# MILL CREEK SURVEY

BY

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# TABLE OF CONTENTS

# INTRODUCTION

A water quality survey was conducted on Mill Creek August 19, 1991 to evaluate instream water quality and assess its impact on the Buffalo River during low flow conditions. A recent water quality report which assessed the macroinvertebrate communities in selected tributaries of the Buffalo National River as well as routine water quality data collected by the National Park Service indicated there may be a water quality problem in Mill creek. The August 19, 1991 survey was conducted by personnel of the Buffalo National River and the Arkansas Department of Pollution Control and Ecology. The results of that survey are presented herein.

Eleven stream stations and the Marble Falls Sewer Improvement District sewage treatment plant were sampled. Parameters sampled or measured were flow, water temperature, pH, specific conductance, dissolved oxygen, BOD5, total suspended solids, turbidity, nitrite+nitrate as nitrogen, ammonia nitrogen, total phosphorus, orthophosphate, and dissolved copper.

# GENERAL DISCUSSION

## WATERWAY DESCRIPTION

Mill Creek is a perennial (below the springs), spring fed stream located in north central Newton county (Figures 1 & 2). It arises south of Harrison in southern Boone County and flows southerly across Newton County to confluence with the Buffalo River just east of Pruitt. Distance from the Highway 7 bridge at Dogpatch to the mouth is about 5 miles. The Arkansas Water Quality Standards (Regulation #2) places Mill Creek in the edge of the Boston Mountain Ecoregion, but based on the type of stream substrate, surface geology, and springs in the area, it appears to be a stream more typical of the Ozark Highlands.

Mill Creek has a total drainage area of 21.3 $mi^2$ (Sullavan 1974). It has an average stream gradient of 40 feet per mile. The estimated bank to bank wetted stream channel width during the survey was about 10 to 30 feet. Estimated average depth was 1 foot. The stream consists of pool-riffles, with an estimated ratio of 40% shallow pools and 60% riffles. Substrate consists of bedrock and/or chert rubble and gravel. The stream loses about 50% of its flow in the upper reaches of the perennial segment.

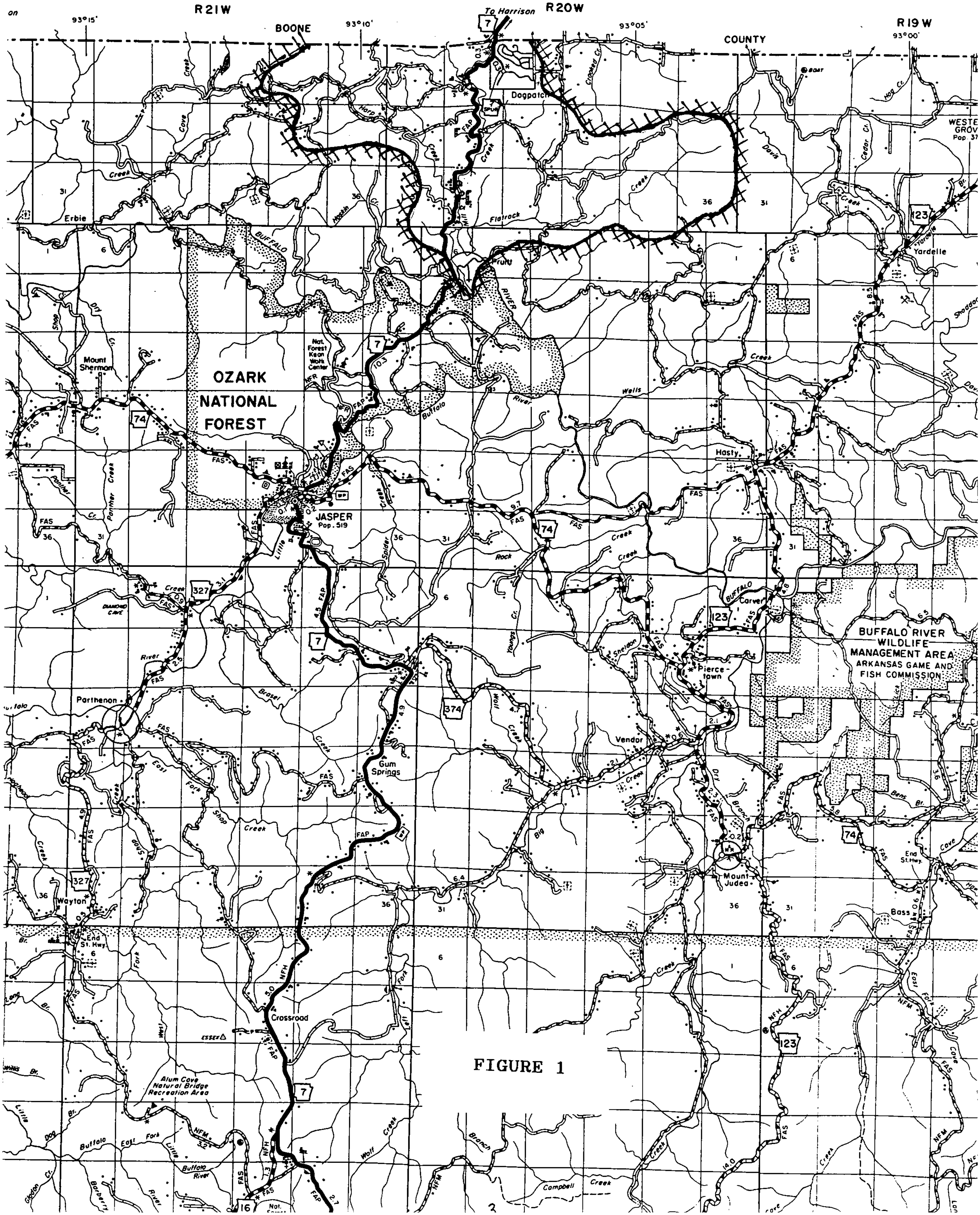

R21W
R20W
R19W
93°15'
93°10'
93°05'
93°00'
BOONE
COUNTY
To Harrison
Dogpatch
Erbie
Mount Sherman
OZARK
NATIONAL
FOREST
Nat. Forest Kean Wolf Center
BUFFALO
RIVER
JASPER
Pop. 519
Diamond Cave
Parthenon
Gum Springs
Vendor
Hasty
Carver
Pierce-town
Mount Judea
Yardelle
BUFFALO RIVER
WILDLIFE
MANAGEMENT AREA
ARKANSAS GAME AND
FISH COMMISSION
Wayton
End St. Hwy.
Bass
Crossroad
Essex
Alum Cave
Natural Bridge
Recreation Area
Campbell Creek
FAS
FAP
NFH
NFM
7
74
123
327
374
16

FIGURE 1

## PREVIOUS STUDIES

The National Park Service has conducted routine water quality monitoring at a site near the mouth of Mill Creek since 1985. Fecal coliform geometric mean values during the last six years were 13 col./100 mL in Mill Creek and 9 col./100 mL in Cecil Creek, a nearby tributary with less development (Mott, 1991). The maximum fecal coliform concentration observed during this period was 3,760 col./100 mL and coincided with a rain event. Fraser et. al., (1988), sampled Mill Creek with the objectives of determining fecal coliform and fecal streptococcus counts and ratios at a number of sites along Mill Creek within the Buffalo National River. Fraser recorded fecal coliform counts as high as 764 col/100 mL and concluded from the FC/FS ratios (greater than 4.0) that human waste was the dominant source of the fecal contamination. Routine National Park Service water quality monitoring has also shown that Mill Creek has the highest nitrite + nitrate as nitrogen (NO3-N) concentration of any of the twenty tributaries monitored on a routine basis. The average NO3-N concentration for the six year period was 0.439 mg/L for Mill Creek and 0.163 mg/L for all twenty monitored tributaries lumped.

As a result of these studies, the NPS contracted with Mathis (1991), to perform a study of the macroinvertebrate community structure at selected sites on the upper Buffalo River including Mill Creek. Data on species (taxon) abundance were analyzed using a number of techniques including species richness (raw richness, rarefracted richness, and Margalef's Index), species diversity (Shannon's Index, Simpson's Index, and Hill's Numbers), community composition (percentage Ephemeroptera, Plecoptera, and Trichoptera to Diptera (EPT:D)), and Hilsenhoff's Biotic Index. Based on these analyses, Mathis concluded that the aquatic insect assemblage has been "impacted substantially" and that values of Margalef's Index indicate that Mill Creek is mildly to moderately polluted. Although the cause of the impacts could only be speculated, Mathis suggested pulses of poor water quality during critical life stages of the less tolerant species and continually higher nutrient concentrations as the dominant causes of the skewed assemblage.

## LAND USE

About forty percent of Mill Creek's originally forested watershed has been converted to pastures, rural residences, and the Dogpatch amusement park and trout farm. Most of the converted land is in pasture, especially in the Harp Creek drainage where approximately sixty percent is in pasture. Cattle grazing is the predominant activity on the cleared areas, whereas logging is common in the forested areas. Approximately three percent of Mill Creek's watershed is within the boundaries of Buffalo National River. The area outside the watershed suspected of supplying recharge to the Dogpatch Springs is mostly pasture and farms.

In contrast to the minor development in most of the Mill

Creek watershed, relatively intensive development has occurred directly adjacent to Mill Creek. Highway 7 runs parallel to Mill Creek and only a few hundred feet to the west. This has allowed easy access to the entire length of this stream. A log of the developments along Mill Creek in a downstream direction follows:

| MILE | |
|---|---|
| 5.0 - 4.35: | Dogpatch amusement park and trout farm |
| 4.35 - 3.0: | One or two houses, stream runs through canyon |
| 3.0 - 1.8 : | Approximately 18 structures consisting of private residences, canoe liveries, and privately owned commercial campgrounds |
| 1.8 - 1.5 : | Old lake bed consisting of approximately 10 acres of exposed sediment |
| 1.5 - 0.0 : | Forested riparian cover mostly within Buffalo National River |

## GEOLOGY

The Mill Creek drainage can be divided into two geologic regions with respect to their influence on Mill Creek. The upper region consists of Mississippian aged sandstones and limestones of the Batesville and Boone/St.Joe Formations, respectively. The Boone/St.Joe Formations are characterized by karst geology and contain innumerable solutionally enlarged fractures, cave systems, sinkholes and solution valleys. Mill Creek is ephemeral where it traverses this section carrying water only in response to heavy rains. Stratigraphically below the Boone/St.Joe Formations is the Ordovician aged Everton Formation consisting of sandstones, limestones, and dolomites. The springs at Dogpatch are located at the unconformable contact between the basal St.Joe limestone and the Newton Sandstone Member of the upper Everton Formation. Mill Creek maintains perennial flow through the Ordovician strata although flow volume is not constant through this section. No major faults transect the Mill Creek drainage but fractures are numerous and trend northeast and northwest. The sedimentary strata dip gently toward the south.

Aley (1989) delineated the recharge area for Mitch Hill Spring, a spring located approximately ten miles southeast of the Dogpatch Springs and having similar geologic characteristics and discharge. Aley demonstrated that Mitch Hill Spring's recharge area extended well beyond the surface drainage divide for the Buffalo River. The ground water recharge area for Mitch Hill Spring was determined to be 20.8 $mi^2$. In the case of the Dogpatch Springs, less than five square miles of surface drainage separates the springs from the surface water divide. Because the volume of discharge from the Dogpatch Springs likely exceeds the amount of recharge occurring in this five square mile area, it is probable that significant spring recharge is occurring to the north of the Buffalo River watershed. Accurate determination of the recharge area would best be accomplished using dye tracing techniques. The Harrison basin lies just to the north of the Buffalo River drainage and is predominantly underlain by Boone limestone.

## WATER QUALITY STANDARDS AND BENEFICIAL USES

### Mill Creek

Based on the stream substrate, surface geology, and springs in the area, Mill Creek is in the Ozark Highland Ecoregion, and would have the associated beneficial uses and water quality standards. The combined outflow from the springs at Dogpatch exceeds 2 cfs, so the stream would have a perennial fishery designation from the springs to the mouth. Some of the applicable standards are as follows:

Dissolved oxygen, Primary = 6 mg/l    Critical = 5 mg/l

Turbidity: 10 ntu

### Buffalo River

The Buffalo River is designated as Extraordinary Resource Waters and Natural and Scenic Waterways. As such, the Antidegradation Policy is applicable regarding water quality impacts of tributaries and land management practices within the watershed of the river, including its tributaries. There should not be any degradation of water quality in the river due to discharges, nonpoint sources, or instream activities within the watershed.

## POTENTIAL SOURCES OF WATER QUALITY IMPACTS

### DOGPATCH

#### Trout farming

The Dogpatch Amusement Park operates a trout hatchery/farm in the two springs and reservoirs of Dogpatch. About 100,000 trout are hatched and raised annually at Dogpatch. The trout are released in the reservoirs and serve as a tourist attraction at the park. Trout chow feeders are provided within the park so visitors can feed and watch the trout. In addition to the chow introduced by park visitors, routine daily feeding consists of about 150 to 200 pounds per day of trout chow in the summer and about 400 pounds per day in late fall and winter. Also, copper sulfate is used at about 4 to 5 pounds per week to control algae during the summer.

The trout operation is a potential source of BOD5, nutrients, and copper.

### STP

The Marble Falls Sewer Improvement District operates a wastewater treatment plant that discharges to a tributary of Mill Creek. The facility has NPDES No. AR0034088, with a design flow of 0.18 mgd and effluent limits for BOD5, TSS, ammonia, and dissolved oxygen of 10/15/2/4 May - Oct. and 10/15/4/4 Nov. - Apr. This treatment plant treats the wastewater from the Dogpatch amusement park.

The plant consists of an activated sludge package plant, a small polishing pond of .5 acres, and chlorination. Discharge is to an unnamed tributary of Mill Creek. However, the discharge flows from the pipe and percolates immediately into the ground. During the survey, there was no flow in the unnamed tributary.

The sewage treatment facility is a source of BOD5, total suspended solids, nutrients, and fecal coliform bacteria, but there are limited by the NPDES permit to meet the receiving stream's water quality standards.

HOUSES/CABINS ALONG MILL CREEK

There are a number of houses, cabins, and trailer houses (about 15 to 20) immediately adjacent to Mill Creek 2 to 3 miles above its confluence with the Buffalo River. Presumably, wastewater from these are treated by septic tanks. They are a potential source of organic waste, nutrients, and bacteria.

CLEARED, OLD LAKE BED

At the site of a former lake located just above the confluence of

Mill Creek and Flat Rock Creek, about 10 acres had been recently bulldozed and graded. This has exposed bare soil over the 10 acre site and caused the banks of the creek to be unstable, resulting in erosion of the stream bank and surface of the cleared area. About a quarter mile section of the creek does not have any canopy or riparian vegetation at this location.

This cleared area is eroding and introducing sediment into the stream, which can result in an increase of turbidity and suspended solids.

NON-POINT SOURCES IN THE WATERSHED

Non-point sources within the watershed such as agricultural activities, silviculture, dirt/gravel roads, and septic tanks are all potential sources of pollution. Non-point source pollution can have significant impact on groundwater in the Boone Formation because of the karst characteristics of the Boone. As the groundwater surfaces via springs such as those at Dogpatch, water quality impairment of surface waters may result.

## METHODOLOGY

Sampling sites were as follows:

1 Mill Creek at the Highway 7 bridge (a spring run below the smaller of the two Dogpatch springs). This site is below trout hatchery pens.

2 Dogpatch spring (The main Dogpatch spring within the park proper)

3 Mill Creek at Marble Falls dam (or Dogpatch dam)

4 Mill Creek at Spring Valley Road

5 Mill Creek 100 ft. above Harp Creek

6 Harp Creek at the Highway 7 bridge

7 Mill Creek below Harp Creek

8 Mill Creek 150 ft. above Flat Rock Creek (below the old lake bed)

9 Mill Creek at the mouth

10 Buffalo River 600 ft. above Mill Creek

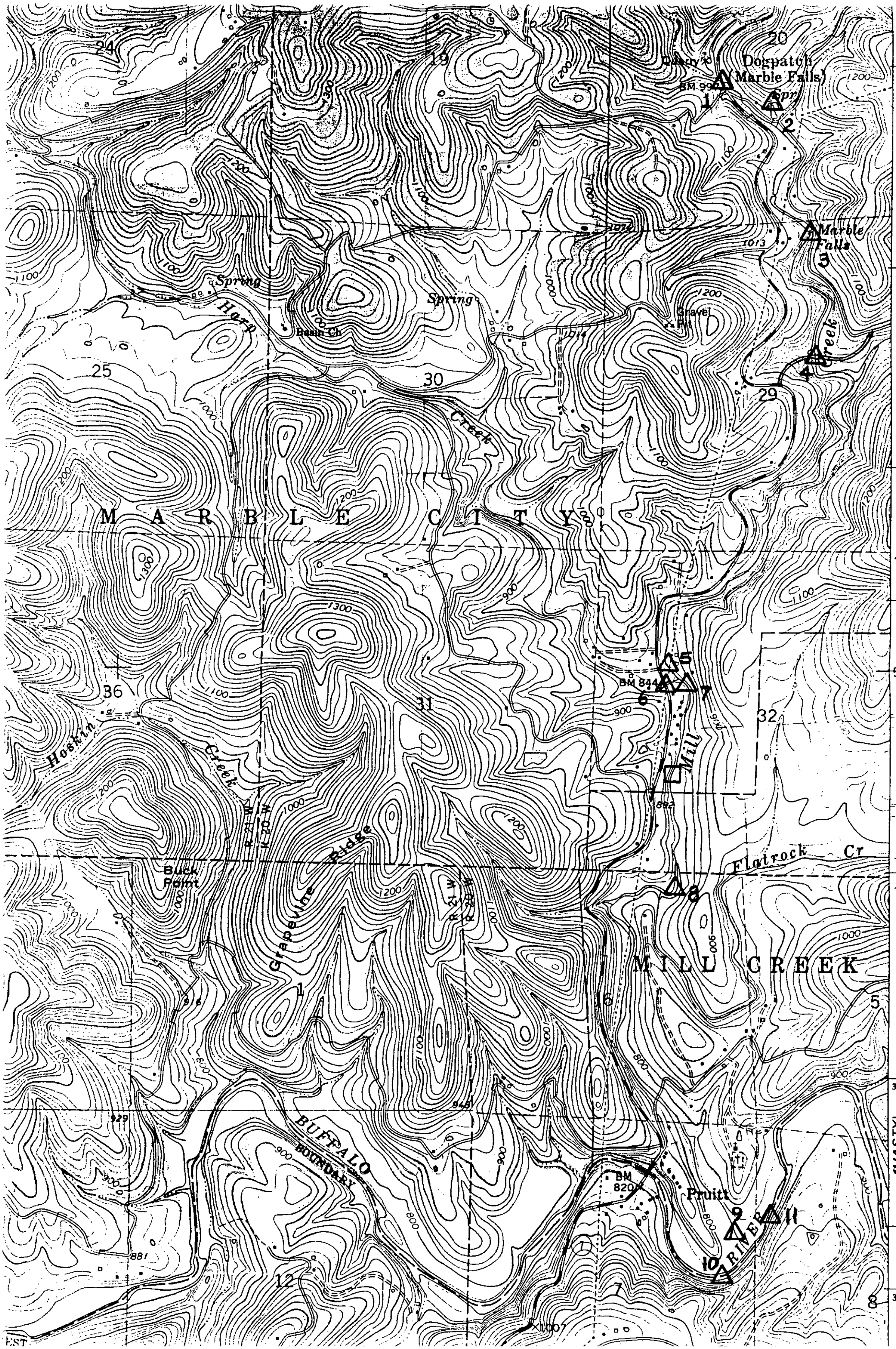
11 Buffalo River 300 ft. below Mill Creek

12 Sewage treatment plant effluent

Stream sampling locations are shown in Figure 2.

### FLOW

Flow was determined by measuring velocity and depth at one foot increments across the stream channel. These values were used to




NORTH
1" = 2000'

FIG 2

SAMPLE LOCATIONS

△ ALL PARAMETER:

□ FECAL COLIFOR & TURBIDITY ONL

determine the total stream flow by calculating the average flow and cross sectional area at each increment and adding them together. A Marsh McBirney Model 201 portable water current meter was used.

D.O./TEMP/Ph/COND

Dissolved oxygen, temperature, pH, and conductivity were measured in the field.

Dissolved oxygen was measured by a Nestor Instruments Model 8500. The dissolved oxygen meter was air calibrated and adjusted for barometric pressure at the beginning of the day.

pH was measured by an Orion Model SA 250 and calibrated to standard buffer solutions of 7 and 10.

Specific conductance was measured with a Yellow Springs Instruments Model 3300. Accuracy is routinely verified using a solution of known conductance.

FECAL COLIFORM BACTERIA

Fecal coliform samples were collected in sterile whirlpak bags and placed on ice immediately following collection. Analysis was by membrane filtration, conducted at the Buffalo National River Water Quality Laboratory in Harrison. Fecal coliform samples were set up the evening of August 19 and results determined the following evening.

GRAB SAMPLES

Grab samples for all other parameters were collected, placed on ice, and transported to the DPC&E laboratory in Little Rock and analyzed within 48 hours. Samples were collected by using virgin polyethylene bottles, which were plunged beneath the water's surface and allowed to fill.

# RESULTS

FLOW

Mill Creek

Flow at the Highway 7 bridge was .9 cfs and at the Dogpatch spring 1.9 cfs, therefore the total flow through the Dogpatch complex was 2.8 cfs. Flow at Spring Valley road about 0.6 mile below the last dam at Dogpatch was 1.5 cfs, thus the stream had lost nearly half its flow at this point. It was not possible to measure the flow at the dam site, but it was estimated to be in the three cfs range. Therefore, the flow is probably lost between the last dam and Spring Valley road. At the confluence with Harp Creek, the flow had recovered to 2.9 cfs and stayed between 2.9 and 3.0 cfs to its confluence with the Buffalo River.

Buffalo River

Flow in the Buffalo upstream of Mill Creek was 4.6 cfs. Flow in Mill Creek at the mouth was 2.9 cfs. Mill Creek made up 39 percent of the flow of the Buffalo below the confluence. Because it makes up over one third of the flow in the river, Mill Creek water quality has a significant effect on the water quality of the Buffalo.

Flow results are presented in Table 1 and shown graphically in Figures 3 and 4.

DO/TEMP/SATURATION

Mill Creek

Dissolved oxygen in Mill Creek varied from 7.2 to 9.8 mg/l. Saturation varied from 82.8% to 111%. Temperature varied from 14.7 degrees Celsius in Dogpatch spring to 28.1 degrees at mile 1.5, just above Flat Rock Creek (a dry streambed at sampling time). Sample times were from 10:25 to 17:15.

The minimum dissolved oxygen of 7.2 mg/l occurred immediately upstream of the last dam at Dogpatch. Apparently, the BOD5 load from the trout chow creates enough of an oxygen demand to increase the D.O. deficit from 0.5 to 1.5 mg/l (a 12% reduction in saturation). Percent saturation at this point was 82%. Reaeration downstream of the dam brings the D.O. back to near saturation. Below Harp Creek, the stream becomes supersaturated (about 110%), and remains so to the mouth.

Temperature also increases below the mouth of Harp Creek and reaches a maximum as Mill Creek flows through the bare area of the old lake. There is no canopy or riparian vegetation along this segment of Mill Creek, about 1/4 mile in length.

Dissolved oxygen and temperature results are presented in Tables 1 and 2 and Figures 5 and 6.

Buffalo River

Dissolved oxygen in the Buffalo varied from 7.2 mg/l (88.9% saturation) upstream to 9.5 mg/l (120.3% saturation) downstream. The extreme value downstream was apparently caused by photosynthesis from numerous algal clumps on the bottom of the pool and other forms of periphyton at this point . These clumps were up to a foot or more in diameter.

CHEMISTRY and BACTERIA

Results are tabulated in Table 2 and shown graphically in Figures 7 through 23.

Ph

Mill Creek

Ph varied from 7.4 at the Dogpatch spring to 8.3 above Harp Creek and Flat Rock Creek. The pH increased quickly to approximately 8 or higher below the springs and stayed in this range for the length of the creek.

Buffalo River

pH increased slightly below Mill Creek, from 7.94 upstream to 8.05 downstream.

BOD

Mill Creek

A significant increase in BOD5 was observed as Mill Creek flowed through the Dogpatch complex. Concentration rose from about 1 mg/l to 3.4 mg/l and the load increased from about 14 lb/day to 50 lb/day. This is probably due to the trout chow fed to the trout in the holding pens and reservoirs and trout excrement. This extra BOD is metabolized as the stream flows from the Marble Falls dam site to Spring Valley Road, returning to about 1 mg/l at Spring Valley Road and remaining at this level to the mouth.

Buffalo River

BOD increases slightly below Mill Creek, from 0.9 mg/l upstream to 1.3 mg/l downstream.

TSS AND TURBIDITY

Total suspended solids and turbidity were low from the Dogpatch Springs but increased through the Dogpatch complex. At the last dam, the turbidity had reached 8 NTU - the standard is 10 NTU. Total suspended solids and turbidity decreased from the dam site downstream to Spring Valley Road and Harp Creek, but were still at or above the values observed at the Dogpatch Springs. Values dropped slightly with the inflow of Harp Creek but increased to the instream maximums just above Flat Rock Creek. This is just downstream of the old lake bed. The increase at this point is probably due to fine sediment being re-suspended and eroded as the creek flows through the old lake bed site.

NH3-N

Ammonia concentrations in both Mill Creek and the Buffalo were low, generally less than .03 mg/l

NO3-N

Mill Creek

Nitrite-nitrate values in the springs feeding Mill Creek are high. The level at Highway 7 was 1.00 mg/l and at Dogpatch spring 1.46 mg/l. Nitrate levels decrease from these levels to the mouth, where the level was 0.35 mg/l. Mill Creek was contributing greater than 96% of the nitrite-nitrate load carried by the Buffalo River below their confluence at the time of the survey. This is the single most significant impact Mill Creek is having on the Buffalo.

Buffalo River

The nitrite-nitrate load in the Buffalo upstream of Mill Creek is less than .2 lb/day, with a concentration of less than 0.01 mg/l. Mill Creek is carrying a load of 5.5 lb/day, which is greater than 96% of the load, as mentioned above.

The measured concentration of nitrite-nitrate in the Buffalo downstream was 0.08 mg/l. However, the calculated concentration from the mixture of the Buffalo upstream and Mill Creek is 0.14 mg/l. The sampling point downstream was in a pool and the Buffalo and Mill Creek flows may have not been thoroughly mixed at the sample location or algae present in the pool may have been rapidly uptaking the nitrates.

Numerous large clumps of algae were noted on the bottom of the pool at the downstream sampling site. The influx of nitrite-nitrate from Mill Creek is providing nutrients for the growth of this algae.

PHOSPHORUS

Mill Creek

Total phosphorus values increased from .01 mg/l at Highway 7 and .04 mg/l at Dogpatch spring to a high of .09 mg/l as Mill Creek flowed through Dogpatch. The increase is probably due to the trout chow and trout excrement. Phosphorus levels drop from the high of .09 mg/l at the Marble Falls dam to 0.01 mg/l at the mouth.

Buffalo River

Upstream total phosphorus was less than the detection limit of 0.01 mg/l. Downstream after mixing with Mill Creek the value was also less than 0.01 mg/l. At low flow, it appears phosphorus in Mill Creek is not having a significant impact on water quality in the Buffalo River.

CONDUCTIVITY

Mill Creek

Conductivity at the Dogpatch Springs was 323 and 319 Umhos/cm respectively. Conductivity increased to 348 at the Marble Falls dam and then generally decreased downstream to 310 uMhos/cm at the mouth.

Buffalo River

Conductivity increased from 238 uMhos/cm upstream to 265 downstream of Mill Creek.

FECAL COLIFORM BACTERIA

Mill Creek

Fecal coliforms were 44 colonies/100 ml at the Highway 7 bridge, decreasing as the creek flowed through the Dogpatch complex, reaching the minimum value of 8 colonies/100 ml at Spring Valley Road . Values jumped up to 68 colonies/100 ml below the cabins along Mill Creek and then declined to 16 colonies/100 ml at the mouth.

TABLE 1
MILL CREEK SAMPLING RESULTS
AUGUST 19, 1991

| SITE | TIME | MILE | FLOW CFS | TEMP CEL. | pH | D.O. mg/l | BOD mg/l | TURB NTU | TSS mg/l | NH3-N mg/l | NO2+NO3 -N mg/l | T.PHOS mg/l | PO4 mg/l | FECAL | COND uMho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HWY 7 BRIDGE | 10:25 | 5.0 | 0.9 | 16.9 | 7.65 | 9.1 | 1.2 | 5.0 | 3.5 | .09 | 1.00 | .01 | .06 | 44 | 323 |
| DOGPATCH SPRING | 11:10 | 4.8 | 1.9 | 14.7 | 7.37 | 9.8 | 0.8 | 4.4 | <1.0 | .02 | 1.46 | .04 | .05 | | 319 |
| DOGPATCH DAM | 12:00 | 4.35 | | 22.6 | 7.92 | 7.2 | 3.4 | 8.0 | 6.0 | .02 | 0.84 | .09 | .02 | 16 | 348 |
| SP.VALLEY RD. | 13:30 | 3.7 | 1.5 | 23.6 | 8.16 | 8.3 | 1.2 | 6.1 | 3.5 | .01 | 0.95 | .06 | .04 | 8 | 335 |
| ABOVE HARP CR. | 15:05 | 2.25 | 2.9 | 23.3 | 8.31 | 8.8 | 1.0 | 5.5 | 5.0 | .02 | 0.77 | .03 | .04 | 32 | 322 |
| HARP CREEK | 14:50 | 2.23 | 0.1 | 24.9 | 7.86 | 7.6 | 0.7 | 3.0 | 1.0 | .01 | 0.10 | .01 | .03 | 68 | 327 |
| BELOW HARP CR. | 14:40 | 2.2 | | 24.2 | 8.20 | 9.3 | 1.0 | 5.0 | 3.0 | .01 | 0.69 | .01 | .02 | 16 | 325 |
| BELOW CABINS | | 1.8 | | | | | | | | | | | | 68 | |
| ABOVE FLTRK.CR. | 15:45 | 1.5 | | 28.1 | 8.32 | 8.8 | 1.2 | 9.2 | 19.5 | .02 | 0.59 | .01 | .02 | 56 | 335 |
| MOUTH | 17:15 | 0.0 | 2.9 | 26.3 | 8.23 | 8.9 | 1.2 | 3.6 | 1.0 | .01 | 0.35 | .01 | .02 | 16 | 310 |

TABLE 2
SAMPLING RESULTS
BUFFALO RIVER UPSTREAM AND DOWNSTREAM OF MILL CREEK
AUGUST 19, 1991

| SITE | TIME | DIST FT. | FLOW CFS | TEMP CEL. | pH | D.O. mg/l | BOD mg/l | TURB NTU | TSS mg/l | NH3-N mg/l | NO2+NO3 -N mg/l | T.PHOS mg/l | PO4 mg/l | FECAL | COND uMho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BUFFALO R. UP | 17:50 | 600 | 4.6 | 27.0 | 7.94 | 7.2 | 0.9 | 2.7 | 1.5 | 0.03 | <.01 | <.01 | .01 | 4 | 238 |
| BUFFALO R. DWN | 16:39 | 300 | 7.5 | 27.8 | 8.05 | 9.5 | 1.3 | 3.4 | 1.0 | .02 | .08 | <.01 | .01 | 16 | 265 |

TABLE 3
SEWAGE TREATMENT PLANT SAMPLING RESULTS
AUGUST 19, 1991

| SITE | TIME | FLOW MGD | TEMP CEL. | pH | D.O. mg/l | BOD mg/l | TURB NTU | TSS mg/l | NH3-N mg/l | NO2+NO3 -N mg/l | T.PHOS mg/l | PO4 mg/l | FECAL | COND uMho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TREATMENT PLANT | 14:00 | 0.01 | 25.1 | 8.11 | 7.6 | 3.1 | 4.0 | 3.0 | 0.04 | 0.91 | 0.75 | 0.57 | 0 | 420 |
| POUNDS/DAY | | | | | | 0.26 | | 0.25 | 0.003 | 0.07 | 0.06 | 0.05 | | |

TABLE 4
LOAD IN POUNDS/DAY

| SITE | BOD lb/day | TSS lb/day | NH3-N lb/day | NO3-N lb/day | P04 lb/day | T.PHOS lb/day |
|---|---|---|---|---|---|---|
| @HWY 7 | 5.6 | 16.4 | 0.4 | 4.7 | 0.3 | 0.05 |
| DOGPATCH SPRING | 8.1 | 10.1 | 0.2 | 14.8 | 0.5 | 0.4 |
| DOGPATCH DAM | 50.4 | 88.9 | 0.3 | 12.4 | 0.3 | 1.3 |
| SP V RD | 10.0 | 29.0 | 0.1 | 7.9 | 0.3 | 0.5 |
| ABOVE HARP CR | 15.6 | 78.1 | 0.3 | 12.0 | 0.6 | 0.5 |
| HARP CR | 0.4 | 0.5 | 0.0 | 0.1 | 0.0 | 0.0 |
| BELOW HARP CR | 16.2 | 48.5 | 0.2 | 11.2 | 0.3 | 0.2 |
| @FLAT R. CR | 19.4 | 315.2 | 0.3 | 9.5 | 0.3 | 0.2 |
| MOUTH | 18.6 | 15.5 | 0.2 | 5.4 | 0.3 | 0.2 |
| BUF R. 600' UPSTR. | 22.3 | 37.2 | 0.7 | 0.2 | 0.2 | 0.2 |
| BUF R. DOWNSTREAM | 40.9 | 52.7 | 0.9 | 5.6 | 0.5 | 0.4 |

## MILL CREEK
## FLOW

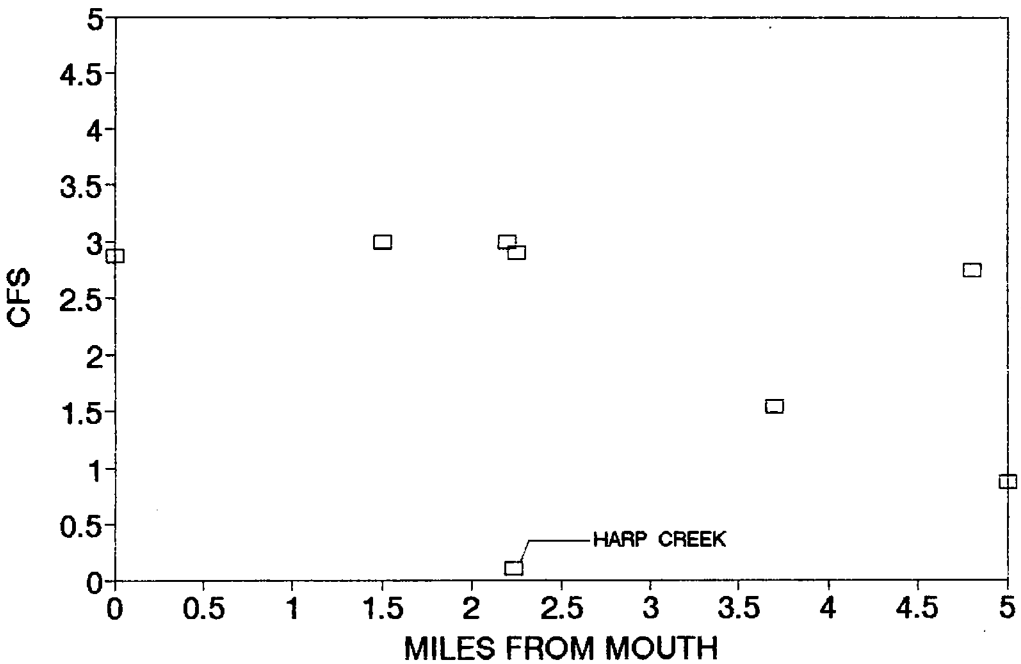



FIG. 3

## BUFFALO RIVER
## FLOW

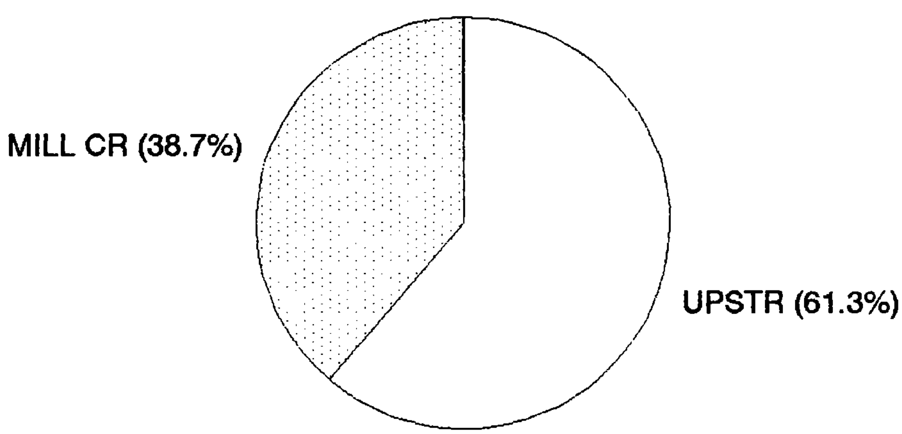
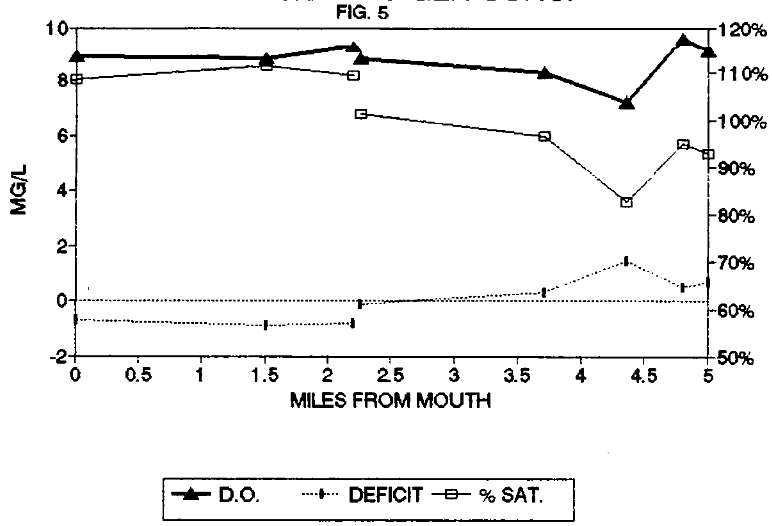
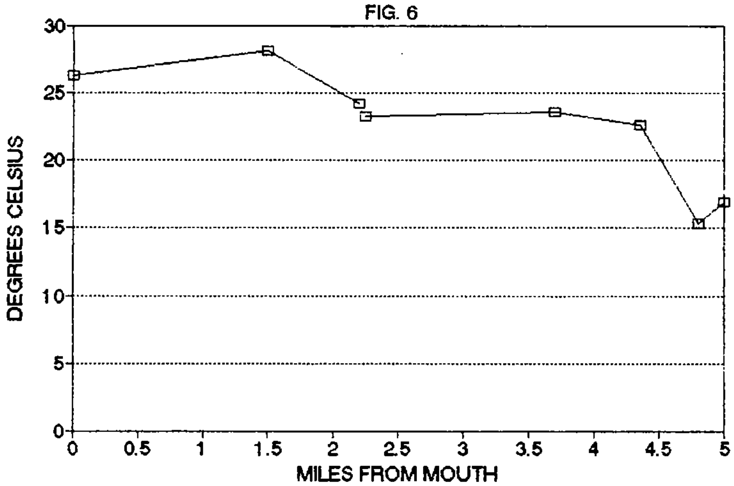



FIG. 4

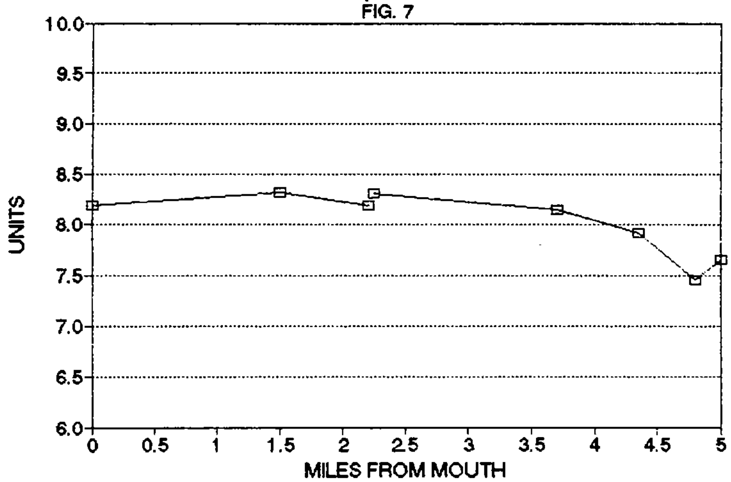
MILL CREEK
DISSOLVED OXYGEN CONC.
FIG. 5



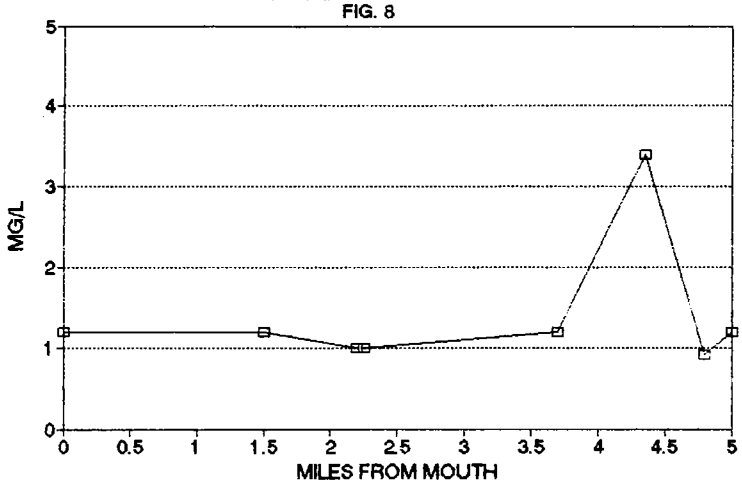

MILL CREEK
TEMPERATURE
FIG. 6



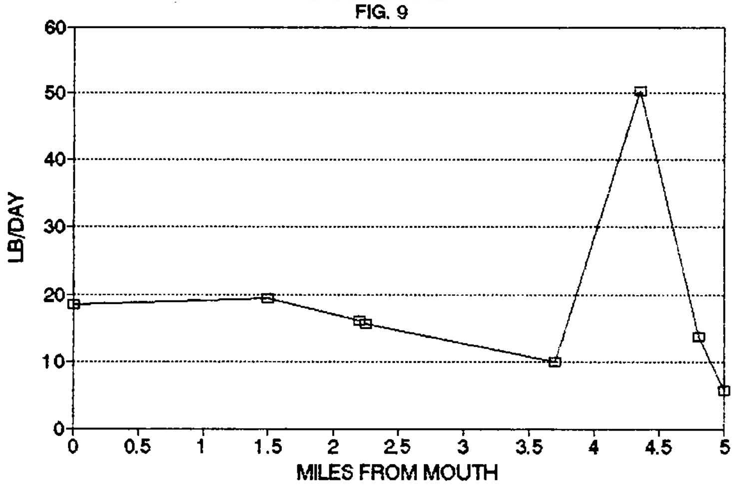

MILL CREEK
pH
FIG. 7



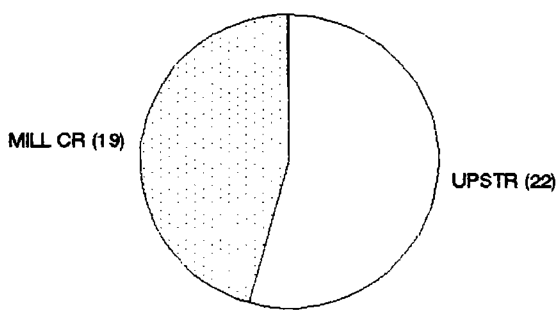
MILL CREEK
BOD CONCENTRATION
FIG. 8




MILL CREEK
BOD LOAD
FIG. 9

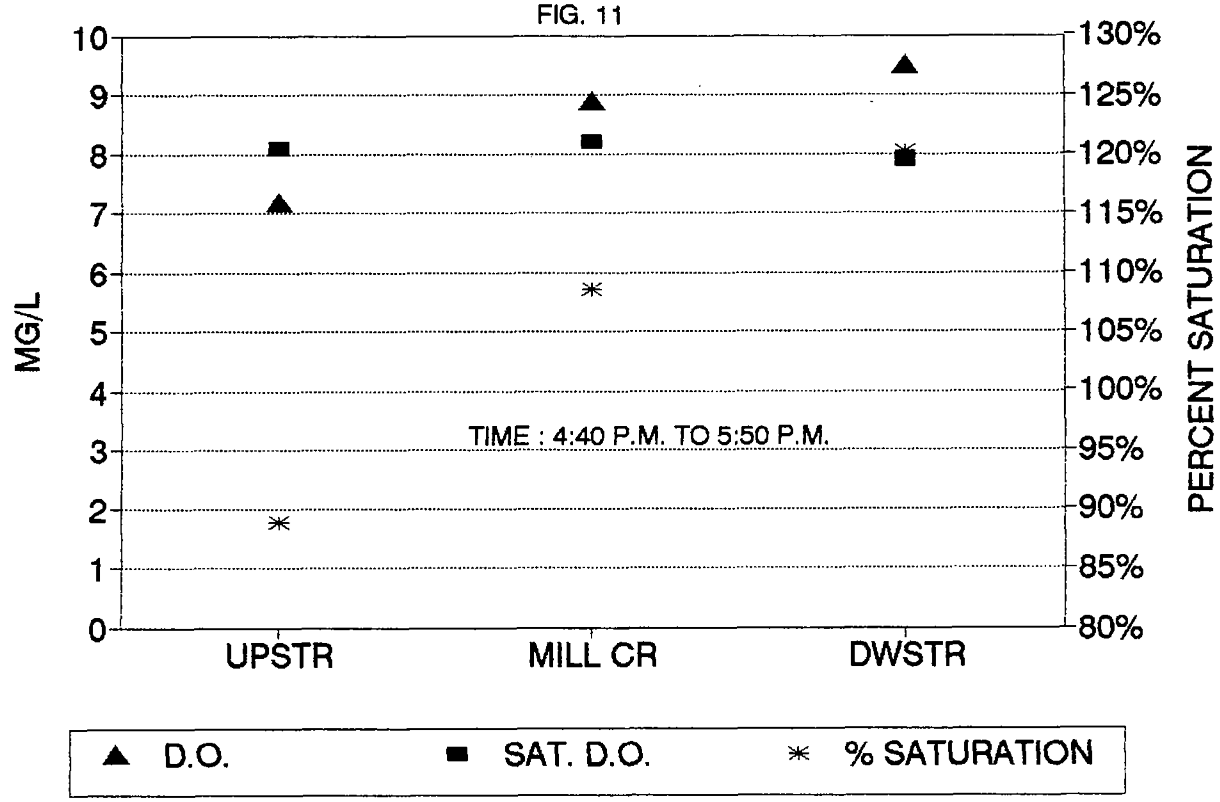



BUFFALO RIVER
BOD LOAD LB/DAY
FIG. 10

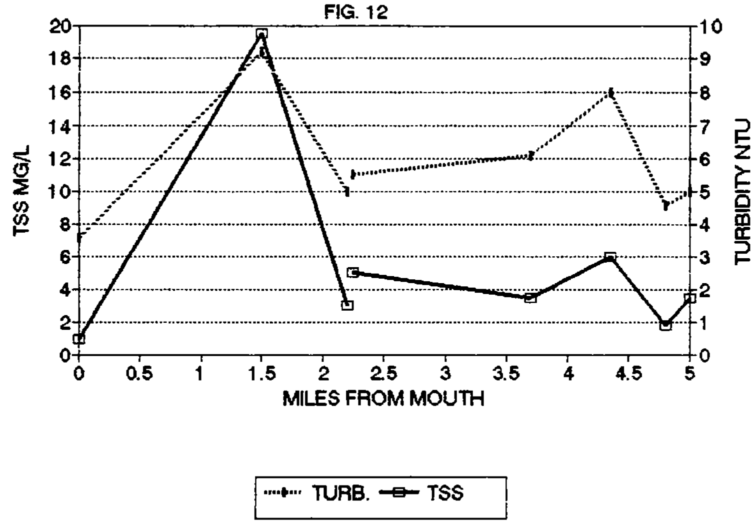


# BUFFALO RIVER
# DISSOLVED OXYGEN

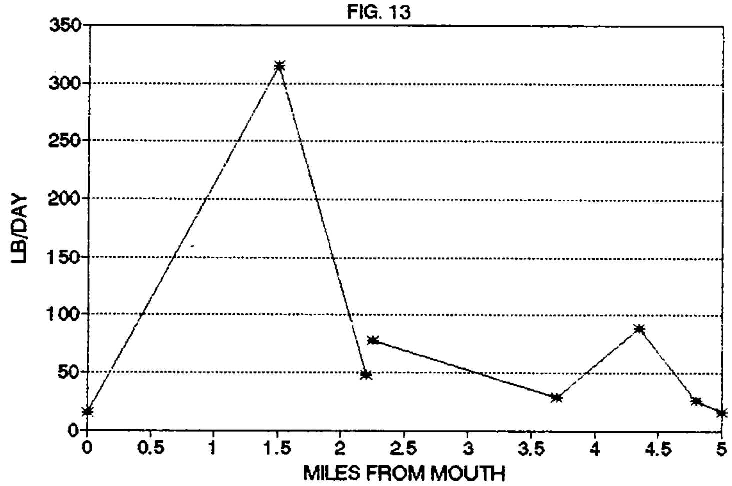
FIG. 11



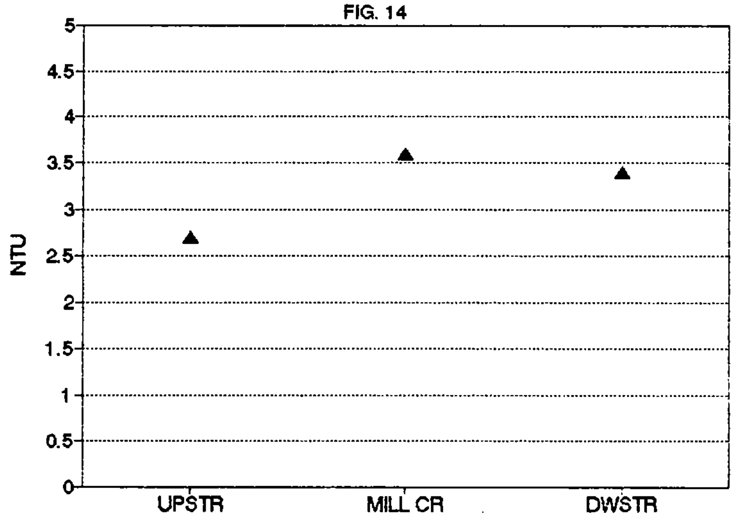
MILL CREEK
TURBIDITY AND TSS
FIG. 12



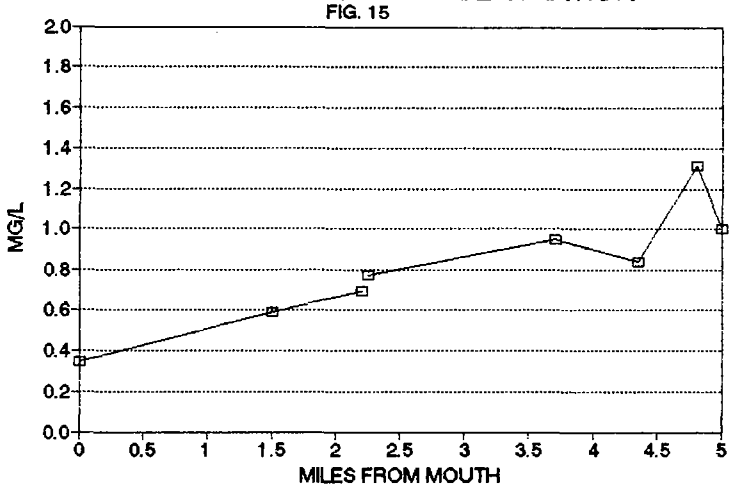

MILL CREEK
TSS LOAD
FIG. 13



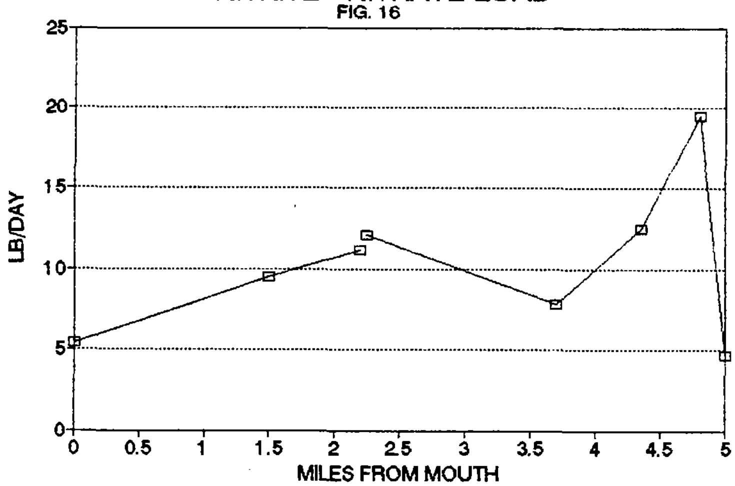

BUFFALO RIVER
TURBIDITY
FIG. 14



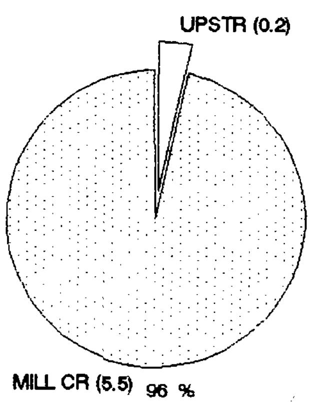
MILL CREEK
NITRITE - NITRATE CONCENTRATION
FIG. 15




MILL CREEK
NITRITE - NITRATE LOAD
FIG. 16

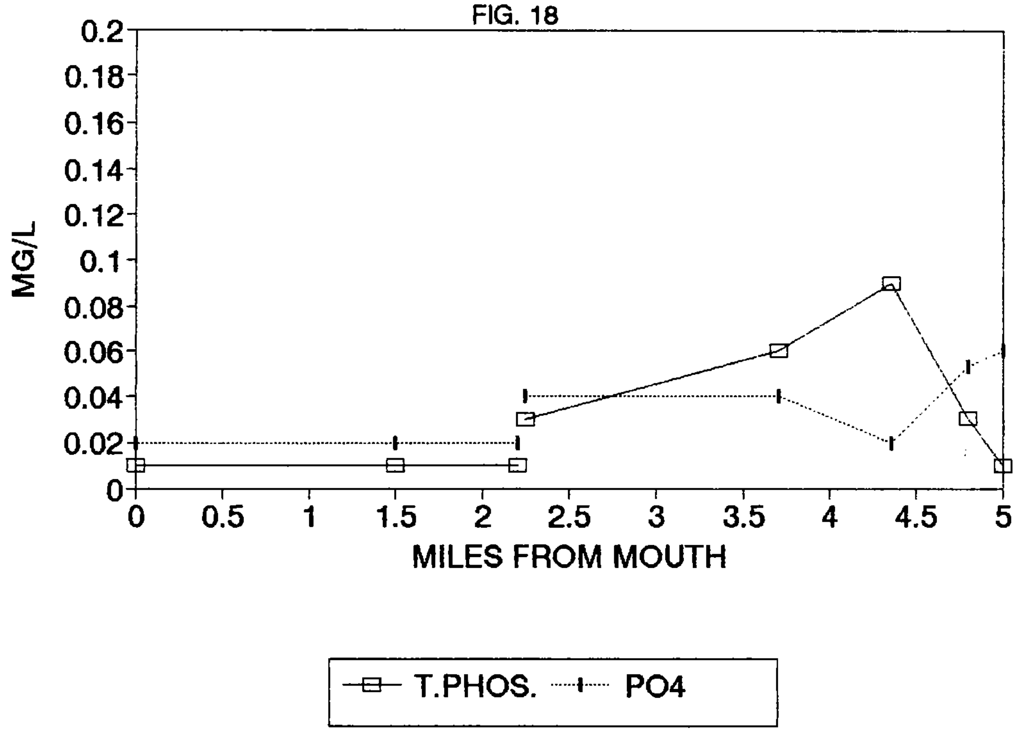



BUFFALO RIVER
NO2+NO3-N LB/DAY
FIG. 17



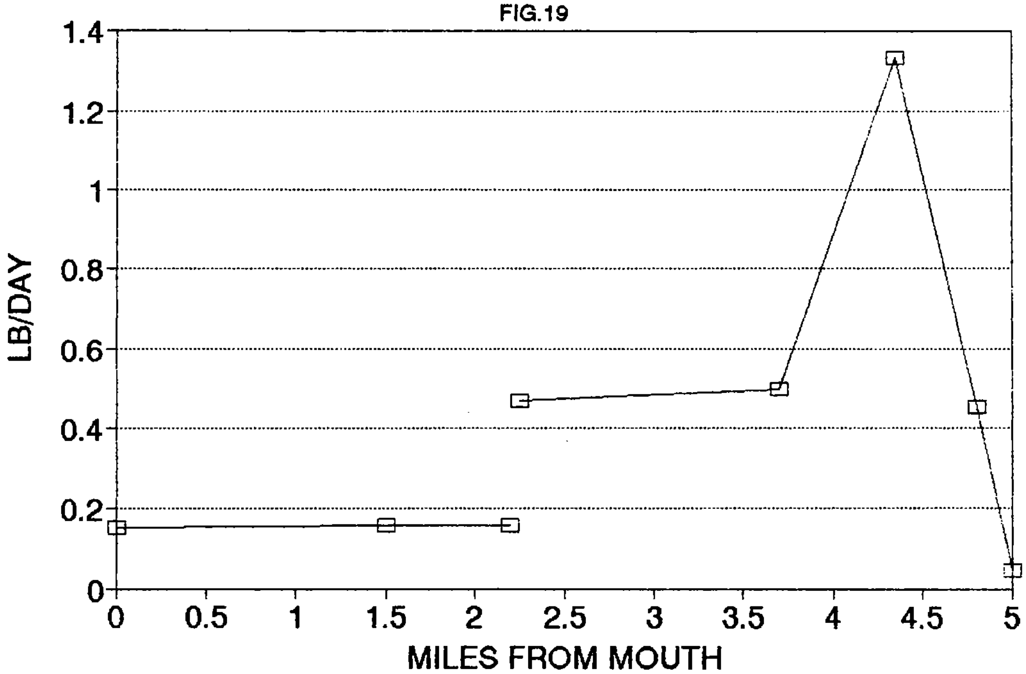
MILL CREEK
PHOSPHORUS CONCENTRATIONS

FIG. 18



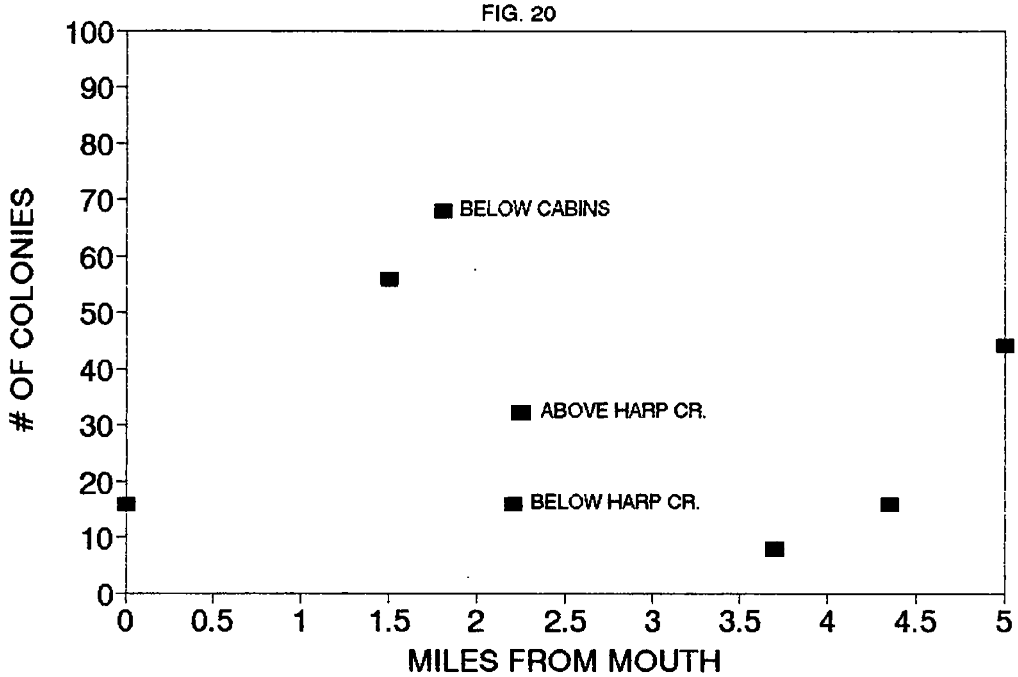

MILL CREEK
T. PHOSPHORUS LOAD

FIG.19



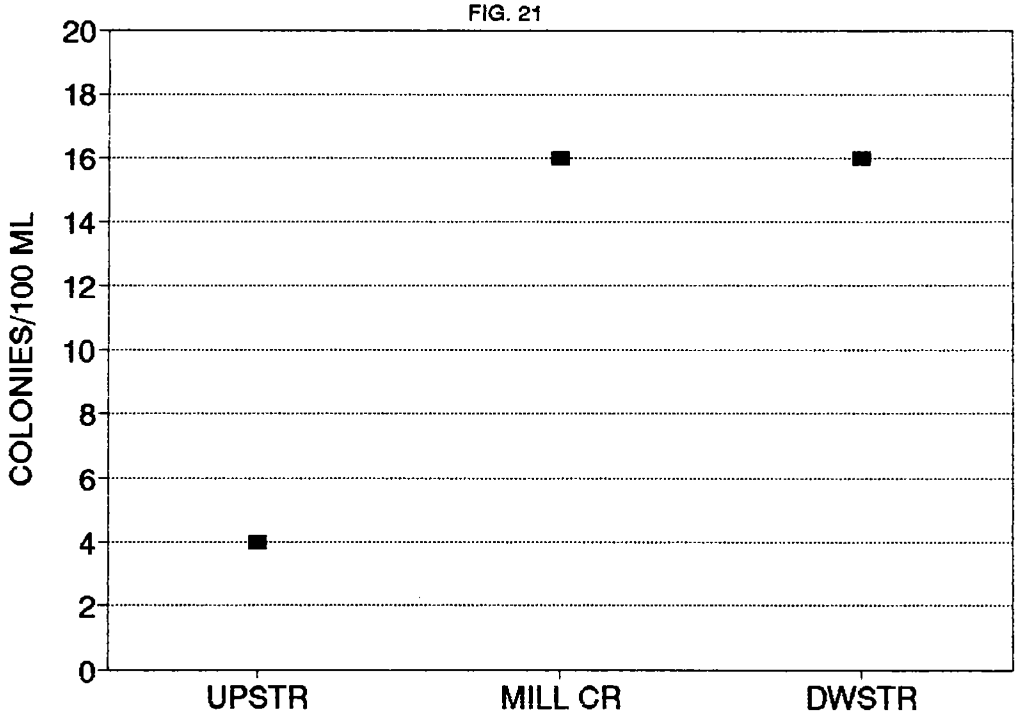
MILL CREEK
FECAL COLIFORM

FIG. 20



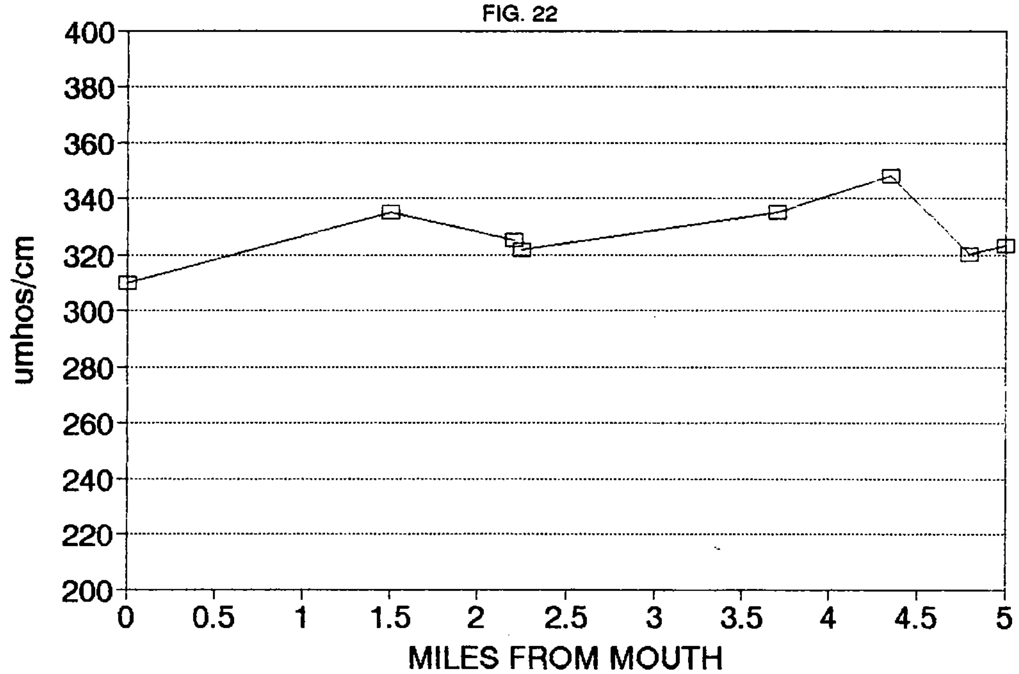

BUFFALO RIVER
FECAL COLIFORM

FIG. 21



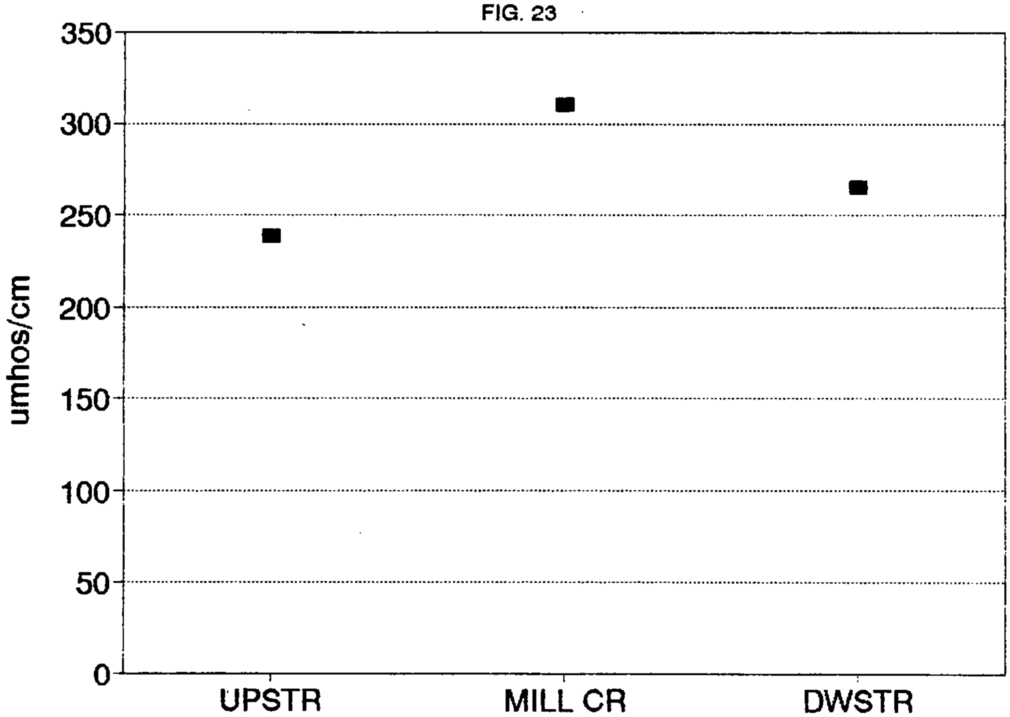
## MILL CREEK CONDUCTIVITY

FIG. 22




## BUFFALO RIVER CONDUCTIVITY

FIG. 23



See figure 20 for a graphic representation of fecal coliform concentrations.

Buffalo River

Fecal coliform increased from 4 colonies/100 ml upstream to 16 colonies/100 ml downstream of Mill Creek.

DISSOLVED COPPER

No dissolved copper was detected in any sample.

SEWAGE TREATMENT PLANT

The sewage treatment plant had a flow of approximately .01 mgd. Parameters were well below permit limits. Because the flow and concentrations were low, daily mass loads were also low, as shown in Table 3. The fecal coliform count was 0 colonies/100 ml.

## CONCLUSIONS

MILL CREEK/BUFFALO RIVER

The major concerns regarding water quality in Mill Creek are the high nitrite-nitrate values in the springs, increase of turbidity and total suspended solids in the old lake bed area, and possibly the BOD5 increase through the Dogpatch complex. The increase of fecal coliform bacteria through the stream segment with a high number of residences adjacent to the creek is also of concern because of the effect this can have on water quality in the Buffalo River. Although water quality standards violations were not observed in Mill Creek during the survey, the turbidity value of 8.0 at the Dogpatch dam and 9.2 NTU at the old lake site are near the standard of 10 NTU.

The main concern regarding water quality in Mill Creek is the potential impact on and degradation of the Buffalo River. There are three areas of concern based on in-field observations and survey results. They are: (1) Nitrite-nitrate; the most significant change in water quality in the Buffalo River downstream of Mill Creek is the nitrite-nitrate increase. Mill Creek is contributing over 96 % of the nitrite-nitrate load carried by the Buffalo River downstream of Mill Creek. Numerous large algal clumps were observed in the river below the confluence with Mill Creek. (2) Erosion and sediment; during high flows and rainfall events, sediment can be eroded from the unstable stream banks and washed into Mill Creek from the cleared area along the old lake site. This material will eventually be carried into the Buffalo River. (3) Fecal coliform; the increase in fecal coliform downstream of Mill Creek. These factors are causing degradation of water quality in the Buffalo River.

SEWAGE TREATMENT PLANT

Water quality impacts of the sewage treatment plant are insignificant due to the small flow and low concentration of pollutants. For example, the BOD5 load from the plant was about .26 lb/day compared to 50 lb/day in Mill Creek at the Marble Falls dam or 18.6 lb/day at the mouth of Mill Creek. Nitrite-nitrate loads from the STP were .07 lb/day compared to 19.5 lb/day from the two springs or 5.4 lb/day at the mouth of Mill Creek.

## RECOMMENDATIONS

### NITRITE-NITRATE

The recharge area of the two springs at Dogpatch should be identified to the extent possible. Field reconnaissance within this area should then be done to identify potential nitrogen sources or land use practices which could introduce nitrite-nitrate nitrogen to the spring recharge area. Best management practices, such as development of nutrient management plans for agricultural operations as prepared by the Soil Conservation Service, should be implemented where feasible.

### SEDIMENT FROM OLD LAKE SITE

Bank stabilization should be implemented throughout the length of this segment and all bare, unvegetated areas should be planted with adequate cover to prevent erosion.

FECAL COLIFORM BACTERIA

Onsite evaluation of the domestic household septic tank systems adjacent to Mill Creek (say 200 yds) should be conducted to see if the systems are operating properly. That is, no surfacing of effluent, leaking systems, or direct discharges should exist.

BOD FROM TROUT OPERATION

To the extent feasible, introduction of trout chow to Mill Creek and the reservoirs should be minimized.

## REFERENCES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